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# Method and device for producing a hard metal tool

The invention relates to a method for producing a bar-shaped hard metal tool comprising at least two materials of different hardness, in which the first material has the lower hardness and forms a bar-shaped support for the second, harder material.

Methods of producing bar-shaped hard metal tools, particularly hard metal drilling tools are known from, for example, DE 40 21 383 C2, DE 41 20 166 C2, WO 01/17705 A2, DE 102 29 325.2 and DE 102 29 326.0. In these known methods there is used in each instance an extrusion tool by means of which a cylindrical body consisting of a plastic mass is produced, the body having one or more recesses extending in its interior. The extrusion tool comprises an extrusion nozzle with a tapering region and a nozzle mouthpiece which forms a cylindrical channel. None of these known methods serves for producing a bar-shaped hard metal tool which comprises at least two materials of different hardness and in which the first material has the lower hardness and forms a bar-shaped support for the second, harder material.

A method of producing a drilling tool, which has a cylindrical base body, is known from US 4 762 445 A. This is conically formed in one end region. It consists of a first material, for example tungsten-carbide, which is fracture-proof, tough, easily capable of soldering or welding and readily sharpenable. Grooves are formed, in particular ground, in this base body. These grooves are filled with a second, extremely hard material, for example diamond or cubic boron nitride. A sintering process is subsequently carried out with use of high pressure and high temperature in order to fixedly connect the two materials together. The said grooves are formed and positioned in such a manner that the diamond layer or the cubic boron nitride forms the cutting edge of the drilling tool.

The disadvantage of this known procedure consists in that introduction of grooves into the base body, which is usually carried out by means of a grinding process, is costly. The ground grooves have only a small depth, i.e. they have only a small extent in longitudinal direction of the tool. This has the disadvantage that the ultimately produced drilling tool can at most be reground a few times and for this reason can be used only for a limited time.

It is already known from GB 882 693 A to feed together mass flows of different metallic materials. This takes place with use of a nozzle arranged between two containers. The mass flows are provided by different press pistons, the extensions of which each protrude into one of the containers. The object of this citation is production of a bimetal with an eccentrically disposed centre of tensile force. Production of a two-component metal bar in which one of the components completely surrounds the other component is not possible by means of the method described in GB 882 693 A.

Similarly, it is already known from US 3 457 760 A to feed together mass flows of different metallic materials. This takes place with use of a special mechanism comprising an electrically heated container. An already present two-component metal bar, in which the second metal component forms a coating of the first metal component, is fed to this container. The said metal components are forced through a specially shaped nozzle with use of a press piston. A two-component metal bar, in which the second metal component forms a coating of the first metal component, is provided at the outlet of the nozzle. By means of the method described in US 3 457 760 A it is possible to undertake merely cross-sectional changes of a bar which is already present.

The invention has the object of indicating a route to production of a hard metal tool

in which the afore-described disadvantages do not arise.

This object is fulfilled by a method with the features indicated in claim 1. Advantageous refinements and developments are indicated in the dependent claims 2 to 12. Claims 13 to 20 relate to a device for carrying out the method according to any one of claims 1 to 12. Claims 21 and 22 have, as subject, a hard metal tool produced in accordance with a method according to any one of claims 1 to 12.

The advantages of the invention consist particularly in that introduction of grooves into the base body is not necessary, since the second material is already introduced into the first material during the extruding. This makes it possible, in particular, to also introduce the second material not only into the edge regions, but also into the inner regions of the first material. The second material can have a substantial extent in axial direction of the bar-shaped tool so that frequent regrinding of the tool can be readily carried out. This significantly prolongs the service life of the tool.

Further advantageous characteristics of the invention are evident from the following explanation of examples of embodiment by reference to the figures, in which:

Figure 1        shows a diagram for clarification of a first example of embodiment for the invention;

Figure 2        shows a diagram for clarification of a second example of embodiment for the invention; and

Figure 3        shows a diagram for clarification of a third example of embodiment

for the invention.

Figure 1 shows a sketch for clarification of a first example of embodiment for the invention. The basic mode of function of the invention is explained on the basis of this diagram.

A bar-shaped blank for a hard metal tool, which comprises two materials of different hardness, is produced by means of the device illustrated in Figure 1. The first material has the lower hardness and forms a bar-shaped support for the second, harder material. The first material is a hard metal having a high level of toughness and thereby fracture-proof to a high degree. Since the first material forms the support for the second material, the ultimately produced tool is fracture-proof by virtue of the toughness of the first material. The second, harder material is preferably similarly a hard material, but has a composition different from that of the first material so as to ensure the desired greater hardness. The second, harder material in this example of embodiment forms the core of the first material, i.e. the centre axle thereof extending in longitudinal direction, but according to further examples of embodiment not illustrated in the figure can also be arranged eccentrically.

Production of a tool of that kind takes place as follows:

In a first extrusion tool P1 the first material, which is present in the form of a plastic mass flow 8, is forced through the wide region 1 of an extrusion nozzle in direction 7 towards the nozzle mouthpiece 2. A tapering region 1a is provided between the wide region 1 and the nozzle mouthpiece 2. The nozzle mouthpiece forms a cylindrical channel.

The second material is provided by a second extrusion tool P2. In this second extrusion tool the second material, which is similarly present in the form of a plastic mass flow, is pressed through the wide region 11 in direction 7 towards the nozzle mouthpiece 12. A tapering region 11a is provided between the wide region 11 and

the nozzle mouthpiece 12. The nozzle mouthpiece 12 forms a cylindrical channel through which the second material in the form of a mass flow is delivered to a feed duct 4. This feed duct 4 is provided between the two extrusion tools P1 and P2. The material provided by the second extrusion tool P2 is conducted by this feed duct to the first extrusion tool P1. The first extrusion tool P1 has in the region of the extrusion nozzle, preferably in the region of the nozzle mouthpiece 2, an inlet opening 13 through which the second material provided by way of the feed duct 4 is received.

The nozzle mouthpiece 2 is of two-part construction in the illustrated example of embodiment, wherein the first part 5a is formed integrally with the wide region 1 and the tapering region 1a of the press nozzle. The second part 5b of the nozzle mouthpiece 2 forms the end region thereof, which can be removed, for example unscrewed, from the first part 5a.

A mount 3, which can be a concentric mounting ring, is inserted into the first region 5a of the nozzle mouthpiece 2. This mount can be easily inserted into the extrusion tool P1 and also easily removed therefrom again when the end region 5b is taken off.

The mount 3 has a channel 3a, the termination of which forms a mount outlet nozzle 10. The channel 3a is connected at the inlet end with a channel 14 provided in the housing of the nozzle mouthpiece 2.

The second material produced by the second extrusion tool P2 and provided by way of the feed duct 4 enters the first extrusion tool P1 via the inlet opening 13 and is there passed on by the channel 14 to the channel 3a of the mount 3. The second material issuing from the outlet nozzle 10 of the mount 3 is forced into the first mass flow. Since the outlet nozzle 10 is arranged centrally in the illustrated example of embodiment the second material forms the core of the first material after being forced in.

Consequently, the cylindrical body 9 issued from the first extrusion tool P1 has a support which forms the entire outer region 9b of the cylindrical body 9 and consists of the first material. The core 9a of the cylindrical body 9 is formed by the second material. This is clarified in the form of a cross-sectional illustration in Figure 1 at the bottom right.

Alternatively to the afore-described example of embodiment the following modifications are possible:

A first modification consists in that the mount 3 is to be designed not in the form of a mounting ring, but in the form of a pin-shaped mounting element. A second modification consists in that the second material is to be forced into the first material not in the form of a mass flow having a circular cross-sectional area, but in the form of a mass flow having a non-round cross-sectional area. An elongate cross-sectional shape extending over half or even over the entire inner diameter of the nozzle mouthpiece is, for example, advantageous. This procedure allows, for example, production of a drilling tool in which the cutting region is formed by the second, harder material.

According to all that, the illustrated example of embodiment discloses a method and a device for producing a bar-shaped hard metal tool having two materials of different hardness. The first material has the lower hardness and forms a bar-shaped support for the second, harder material. The first material is pressed within a first extrusion tool in the form of a plastic mass flow in the direction of the nozzle mouthpiece of an extrusion nozzle. The second material, which is present in the form of a plastic mass flow and which is preferably provided by a second extrusion tool, is forced within the first extrusion tool into the first mass flow.

The bar-shaped, preferably cylindrical body issued from the first extrusion tool P1 is further processed to form a finished hard metal tool, preferably a hard metal drilling tool or a hard metal milling tool.

Within the scope of this further processing the body leaving the first extrusion tool P1 is cut to length outside the extrusion tool P1 to a desired length. Subsequently, the body cut to length can be uniformly twisted by means of a surface friction arrangement such as described in more detail in, for example, WO 01/17705 A2. The cut-to-length and twisted or untwisted body is dried, optionally provided at its outer circumference with one or more chip chambers and finally sintered.

Through this procedure there is obtained a hard metal tool which, by virtue of the characteristics of the first material, is fracture-proof and, by virtue of the characteristics of the second material, is extremely hard in the working range.

Figure 2 shows a diagram for clarification of a second example of embodiment for the invention, which corresponds with a development of the example of embodiment shown in Figure 1. According to this second example of embodiment additionally a third material, which either has the same characteristics as the second material or which has other desired characteristics, is provided with use of a third extrusion tool P3. This third material is fed to the first extrusion tool P1 by way of a further feed duct 20. The third material produced by the third extrusion tool P3 and provided by way of the feed duct 20 enters via an inlet opening 18 into the first extrusion tool P1 and is there passed on by a channel 19 to a channel 3b of the mount 3. The third material issuing from the outlet nozzle 10b of the mount 3 is forced into the first mass flow just as the second material issuing from the outlet nozzle 10a of the mount 3.

In this example of embodiment a cylindrical body 9 issues from the first extrusion tool P1. This body has a support which forms the entire outer region of the cylindrical body and consists of the first material. Two inserts are provided within this support 9b as evident from the upper cross-sectional illustration in Figure 2 at the bottom right. The insert 9d consists of the second material and the insert 9c of the third material.

A modification of the example of embodiment according to Figure 2 consists in that

the outlet nozzles 10a and 10b of the mount 3 are selected to be rectangular in such a manner that the inserts 9c' and 9d' form the cutting edges in the finished drilling tool. This is clarified in the lower cross-sectional illustration in Figure 2 at the bottom right. The curved form of the inserts can be achieved in that the outlet nozzles 10a and 10b of the mount 3 already have a curved shape or in that the cylindrical body issuing from the first extrusion tool P1 is initially cut to length outside the first extrusion tool P1 and then twisted in desired manner.

Figure 3 shows a diagram for clarification of a third example of embodiment for the invention, which corresponds with a development of the example of embodiment shown in Figure 2.

In this example of embodiment a control unit 21, sensor system 22, valve 23 and valve 24 are provided additionally to the example of embodiment shown in Figure 2. The valve 23 is disposed between the second extrusion tool P2 and the first extrusion tool P1 in the feed duct 4. The valve 24 is arranged between the third extrusion tool P3 and the first extrusion tool P1 in the feed duct 20. The sensor system 22 is provided outside the first extrusion tool P1 in the outlet region of the cylindrical body 9 and serves for travel or outlet speed measurement or detection when the cylindrical body issued from the first extrusion tool P1 has reached a predetermined position. When the issued cylindrical body has reached the predetermined position a sensor system 22 provides an output signal ss.

This is fed to the control unit 21 and taken into consideration by this in the determination of control signals s1, s2, s3 and s4. The control signal s1 serves for setting the speed of movement of the piston 6 arranged in the second extrusion tool P2. The control signal s2 serves for controlling the valve 23. The control signal s3 serves for setting the speed of movement of the piston 17 provided in the third extrusion tool P3. The control signal s4 serves for controlling the valve 24. Further control signals of the control unit 21 serve for setting the volume flow of the first material in the first extrusion tool P1.

The said control or setting of the volume flows is carried out in such a manner that, for example, the second and third material, which forms the cutting region of the later drilling tool, is forced into the first material only in the front half of the drilling tool. The circumstance is thereby taken into account that the rear region of the finished drilling tool is clamped in a drill chuck during working operation and at no time forms the cutting region. This procedure is connected with a saving of costs, since the second material and third material, which form the cutting region of the drilling tool and for this reason have to be extremely hard, are in general substantially more expensive than the first material, which has a lesser hardness.

Preferably, all materials employed are hard material components each having the desired characteristics. This also has the advantage of simplified recycling, because the entire product merely consists of hard metal components. No solder connections are present and also no different substances have to be disposed of.

Alternatively thereto, however, it is also possible to use, as harder material which forms the cutting region of the later drilling tool, polycrystalline diamond (PCD) which is also used in previously known drilling tools in the cutting region.

The method according to the invention and the device according to the invention can, according to all that, be used for the purpose of producing bar-shaped hard metal drilling or milling tools, which have as support material a first hard metal type with a high degree of toughness and comparatively low hardness. Hard metal types of that kind have, for example, a high cobalt proportion and a comparatively coarse grain size which is not suitable for the cutting region of a hard metal tool. Hard metal categories of that kind are comparatively favourable in price. Within the scope of an extrusion process there is forced into this support material a cutting material which is preferably a hard metal type with a very high degree of hardness and very fine grain size in order to do justice to the requirements in the cutting region of a hard metal tool. Alternatively thereto, polycrystalline diamond can also be used in the cutting region.

The produced tools can also be reamers.

The produced tools can - as is known from, for example, WO 01/17 705 A2 - have internally disposed cooling channels through which a liquid coolant is led to the working region of the respective tool during working operation thereof.

Alternatively to the above forms of embodiment there can also be used, instead of piston presses, also worm presses when the volume flow is known for every press participating in the production process.

## Reference Numeral List

P1	first extrusion tool
P2	second extrusion tool
P3	third extrusion tool
1	wider region of an extrusion nozzle
1a	tapering region of the extrusion nozzle
2	nozzle mouthpiece
3	mount
3a	channel in the mount
3b	channel in the mount
4	feed duct
5a	first region of the nozzle mouthpiece 2
5b	end region of the nozzle mouthpiece 2
6	piston of the second extrusion tool
7	extrusion direction
8	plastic mass
9	cylindrical body
9a	core of second, harder material
9b	support of first, softer material
9c	insert of second, harder material
9d	insert of third, harder material
10	mount outlet nozzle
10a	mount outlet nozzle
10b	mount outlet nozzle
11	wider region of the second extrusion nozzle
11a	tapering region of the second extrusion nozzle
12	nozzle mouthpiece of the second extrusion nozzle
13	inlet opening
14	channel in the nozzle mouthpiece 2
15	wider region of a third extrusion nozzle
15a	tapering region of the third extrusion nozzle

16	nozzle mouthpiece of the third extrusion nozzle
17	piston of the third extrusion tool
18	inlet opening
19	channel in the nozzle mouthpiece 2
20	feed duct
21	control unit
22	sensor system
23	valve
24	valve
s1, s2, s2, s3, s4	control signals
ss	output signal of the sensor system 22